THE BERRY HILL - RAINWORTH TREMOR OF 26th JANUARY 1973

by

R.E. Elliott

Summary

A minor earth-tremor centred between Berry Hill at Mansfield and Rainworth, occurred at 05.07 hours on Friday, 26th January 1973. Evidence suggests that this originated on structures in sub-Carboniferous rocks; the Mansfield Anticline and its associated major fault being the near surface expressions of those structures.

Introduction

A small tremor was experienced for some 2 - 3 seconds by persons resident in the vicinity of Mansfield, Nottinghamshire, early on Friday, 26th January 1973. Verbal reports were collected by the author from an area of some 60-70 square miles ranging from Warsop to Bestwood on the northern outskirts of Nottingham City, and from the western side of Mansfield to Bilsthorpe (text-fig.1). However, five miles further south on the Trent embankment at Nottingham, one observer noticed "a slight unmistakeable tremor", whilst sitting. The greatest concentration of reports was from the Forest Town and Berry Hill districts on the east side of Mansfield and from Rainworth. Reports of damage were rare and very slight. A second tremor was noticed by a few persons at about 11.15 or 11.20 a.m. on the same day, again east of Mansfield.

This tremor was one of the stronger ones of a series felt in the same general district over at least the last 20 years. These minor shocks have not, so far as the author is aware, been studied in detail and have usually been on a scale which does not readily allow investigation.

Scant information concerning earlier tremors was collected by Davison (1924). He reported earthquakes in the Mansfield district on three occasions; one in 1816 which caused slight damage to chimneys and other structures in Mansfield, Kirkby and Newstead and estimated to have attained intensity VI (Modified Mercalli, see appendix), 7 (Davison); a second in 1817 felt at Mansfield and neighbouring villages, and a third in 1825 reported from Mansfield and Newstead Abbey, reaching intensity III/IV (Modified Mercalli), 4 (Davison).

Details

Text-fig.1 records the location of verbal reports, most known to be from reliable sources. Three zones are based on these reports; an outer 'dashed line' encloses all positive records of the tremor being felt and excludes localities where reports would have been likely to be forthcoming had the tremor been detectable by the inhabitants in general. A second line encloses most locations from which members of the public took trouble to report the incident voluntarily. The third, inner 'dashed line' encloses an area from which a large proportion of the residents noticed the tremor and from which a few reports (1 to 4) provided special evidence. Not all reports are plotted in this inner zone.

At location 1, a household pendulum clock was stopped and recorded 05.09 hours; the pendulum is about 16 inches long and swings in the directions indicated on text-fig.1 by arrows. At point 2, a locked door was "burst open"; near 3, a few books and other articles fell to the ground and a greenhouse was said to have "dropped 6 inches"; at 4, miners at a depth of

Mercian Geologist, Vol. 5. No.1, 1974. pp. 33-37, 1 text-fig.

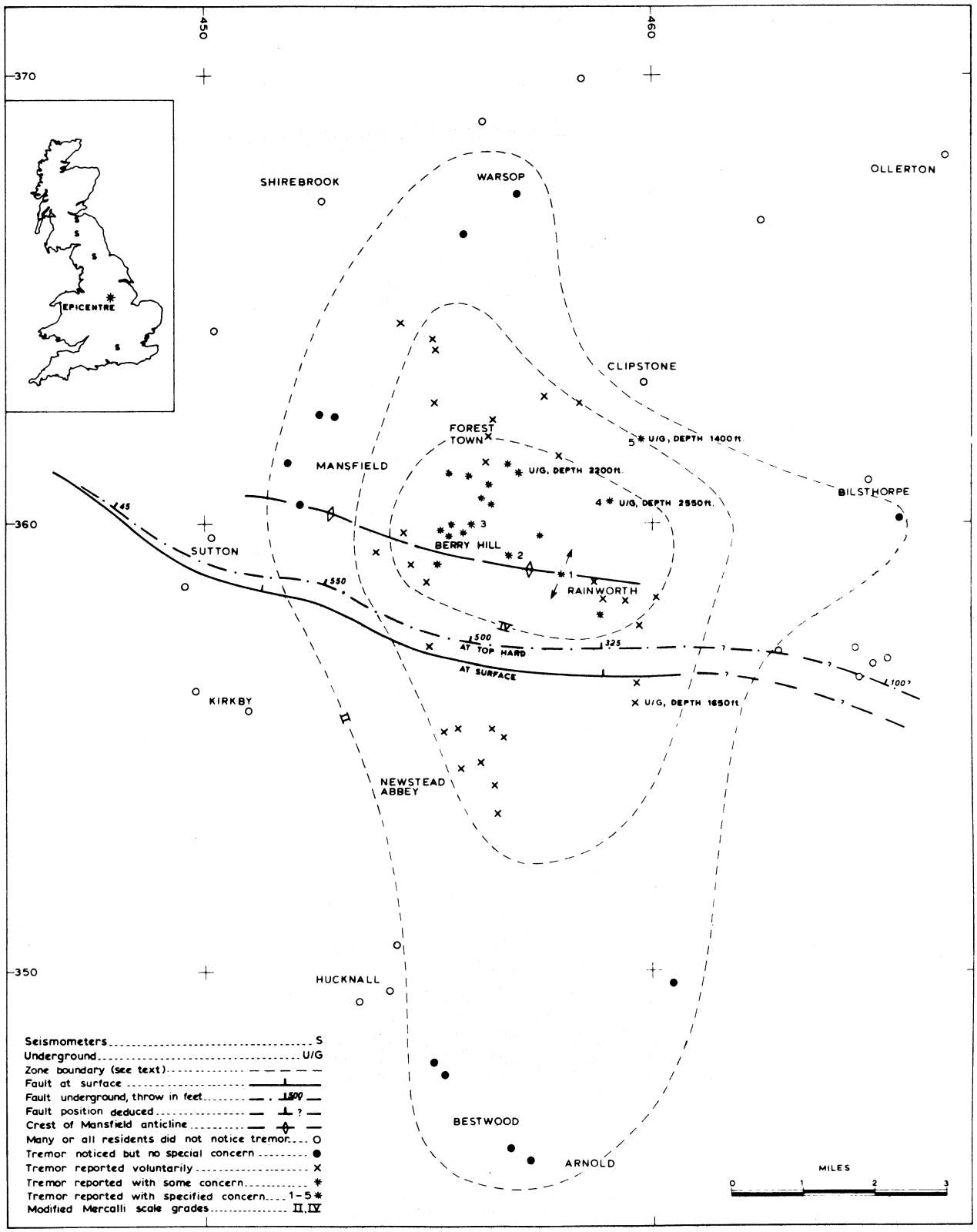

Fig. 1 Isoseismal Map of the Berry Hill - Rainworth Tremor.

2.550 ft. were concerned about the tremor, and at 5, miners at a depth of 1,400 ft. withdrew from an area of fragile roof strata. However, since at this latter locality there was special concern about the nature of the mining conditions independent of the tremor it is not enclosed by the inner line.

Many lights were turned on in the Berry Hill residential district as the inhabitants were awakened by the tremor; this evidence together with that from localities 1, 2 and 3, suggests that the surface epicenter from this tremor was within the Berry Hill - Rainworth district. A maximum intensity of V on the 12-degree Modified Mercalli scale is here interpreted from these reports. This may have been restricted to a narrow zone extending from Berry Hill to Rainworth (text-fig. 1), no more than one mile wide; moreover, because there are no habitations or other possible sources of evidence in parts of the area concerned, the Vth isoseismal is omitted from text-fig. 1. Also, since intensity III is difficult to define only the IInd and IVth isoseismals are labelled.

The tremor was clearly recorded on the Institute of Geological Sciences telemetered array of seven seisometers centred on Edinburgh. A magnitude of 3.5 on the body wave scale and 3.6 on the Richter local scale was registered and an origin at 05.07 hours was calculated. Signals recorded on the Atomic Energy Authority arrays of instruments at Eskdalemuir in Southern Scotland and Wolverton in Hampshire had arrival times of 05.07.36 and 05.07.27 respectively. These confirm that the time of origin was about 05.07 hours. They both gave an Estimated Richter magnitude (m_b) of about 3.0. Strain amplitude records produced by instruments set up in the Queensbury (SE 096300) and Woodhead (SE 137012) tunnels in Yorkshire by the Cambridge University Department of Geolesy and Geophysics did not show significant features; at both localities the strain amplitude was less than one part in 10^9. The seismic records of the University of Durham, Department of Geology, located at Rookhope, County Durham, show a disturbance at 05.07.30 hours.

Discussion

The local nature of the tremor, as felt by residents, and the maximum intensity of V suggests that its origin may be at a relatively shallow depth in seismological terms. This is given approximate quantification in the formula:

$$I_o - I_n = 4.5 \text{ Log}_{10} r_n/h \qquad \text{Karnik (1969, pp 29 and 32)}$$

where I_o is maximum intensity, I_n is intensity at a well founded isoseismal, r_n is the average radius of that isoseismal and h, is the depth of origin. The calculated value of h is of the order of 7,000 to 10,000 ft.

A normal fault (text-fig. 1), trending east-south-east just south of the probable epicenter, is recorded at the surface and in coal workings at the Top Hard seam horizon. Its calculated hade at several points is about 45 degrees and it throws coal measures down on the north side about 500 ft. It faces the southern limb of the so-called Mansfield Anticline. This, the dominant limb, together with the 500 ft. fault, forms a "trap-door" like structure which is one of the major tectonic features of the East Pennine Coalfield. This faulted anticline is one of a number of major fault-fold combinations, which Kent (1966) suggested were related to a pattern of basement fractures.

The floor of relatively dense high-velocity pre-Carboniferous rocks lies below the epicenter (text-fig. 1) at an estimated depth of about 9,000 ft. (Plate 5, Kent 1967). Movement giving rise to the tremor may well have occurred within that floor. Extrapolation of the 45 degree fault hade suggests that the location of the movement was on that fracture or an associated fracture, since at this same order of depth it would lie below the Berry Hill - Rainworth district. However, it is possible that the corresponding basement structure is complex.

The north to south elongation of the IInd isoseismal does not necessarily detract from this interpretation, it may be due to the tremor being more readily felt on the relatively rigid "Bunter" sandstone outcrop than on the adjacent "Marl" formations.

Acknowledgements

The author is indebted to Dr. R.C. Lilwall of the Institute of Geological Sciences, Edinburgh, Dr. H.I.S. Thurlaway of the Atomic Energy Authority, Dr. R.G. Bilham of the Department of Geodesy and Geophysics, Cambridge University and Mr. R.G. Riddle of the Department of Geology, University of Durham, for statements incorporated in the text and to Dr. R.C. Lilwall and Dr. P.E. Kent for reading the draft and offering comments.

References

DAVISON, C. 1924. *A history of British earthquakes.* Cambridge Univ., xviii, 416 pp.

KARNIK, V. 1969. *Seismicity of the European Area.* Dordrecht, Holland. 364 pp.

KENT, P.E. 1966. The structure of the concealed Carboniferous rocks of north-eastern England. *Proc. Yorkshire geol. Soc.*, vol. 35, pp. 323-352.

KENT, P.E. 1967. A contour map of the sub-Carboniferous surface in the north-east Midlands. *Proc. Yorkshire geol. Soc.*, vol. 36, pp. 127-133.

R.E. Elliott, B.Sc., F.G.S.,
Geological Service,
National Coal Board,
Eastwood Hall,
Eastwood,
Notts.

APPENDIX

Modified Mercalli Intensity Scale of 1931

(Details selected [by the author] from several abridged versions

I Not felt by public; detected by seismometers.

II Felt only by some persons, usually at rest.

III Felt indoors but many people do not recognise it as an earthquake; vibrations like passing of a light lorry.

IV Felt by some persons outdoors; hanging objects swing; some loose objects disturbed including dishes, windows and doors; vibrations like passing of a heavy lorry or jolt like a heavy ball striking a wall.

V Felt by nearly everyone; most or many awakened. Small unstable objects displaced.

VII Many persons frightened and ran outdoors; slight damage to plaster, windows, dishes, glassware; small articles fall off shelves or pictures off walls; furniture disturbed. Trees and bushes rustled and all suspended objects swing.

VII General alarm; walls crack; plaster falls; some chimneys and other susceptible structures damaged; water disturbed and ponds become muddy; noticed by drivers of motor cars in motion.

VIII Car drivers seriously disturbed; masonry fissured; chimneys fall; poorly constructed buildings damaged.

IX Some houses collapse where ground begins to crack, and pipes break open.

X Ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes.

XI Few buildings remain standing; bridges destroyed; all services (railways, pipes and cables) out of action; great landslides and floods.

XII Total destruction; objects thrown into air; ground rises and falls in waves.